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ANTIFERROMAGNETISM IN $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ NANOPARTICLES STUDIED BY ELASTIC NEUTRON SCATTERING

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The interplay between antiferromagnetism and superconductivity in the compound $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ in bulk form has been intensively studied; see for instance.¹ We have initiated a similar study but now focusing on the properties as the size of $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ nanoparticles becomes comparable to the coherence length for superconductivity. Here we present the first results on the antiferromagnetic phase of $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$ ($x = 0.15$, $x = 0.25$ and $x = 0.37$) nanoparticles, i.e. the behaviour of the Néel temperature for the various degrees of oxygen doping, studied by elastic neutron scattering.

The YBCO nanoparticles were prepared by a citrate gel modification of the sol-gel technique as described in², and subsequently reduced in a N_2 atmosphere to zero oxygen doping. The YBCO nanoparticle powder were in a controlled manner oxidized in an O_2 atmosphere obtaining different degrees of oxygen doping, i.e. $x = 0.15$, $x = 0.25$ and $x = 0.37$. The composition, crystal structure and the nanoparticle size and shape was characterized by x-ray powder diffraction and high resolution electron microscopy showing that the main part of the nanoparticles are pure tetragonal phase $\text{YBa}_2\text{Cu}_3\text{O}_{6+x}$, however a few percent of the impurity phase $\text{Y}_2\text{Cu}_2\text{O}_5$ is present. The YBCO nanoparticles are disk-shaped with the Cu-O planes perpendicular to the short axis of the disk and have an average diameter of 50 nm.

The elastic neutron scattering was performed at the triple-axis spectrometer RITA-2 at SINQ, Paul Scherrer Institute, Switzerland. The spectrometer was run at 5meV, and the beam was defined by slits at the monochromator, at the sample and at the analyser. A Be-filter with radial collimators was inserted between sample and analyser to reduce higher order scattering. Elastic q -scans were measured on the samples in the temperature range 15 K to 500 K. In the q -range we have studied there are two antiferromagnetic reflections, i.e. $(\frac{1}{2} \frac{1}{2} 1)$ and $(\frac{1}{2} \frac{1}{2} 2)$, but due to the very low intensity we have focussed our study on the $(\frac{1}{2} \frac{1}{2} 1)$ reflection. We have measured the behaviour of this reflection with temperature for $x = 0.15$, $x = 0.25$ and $x = 0.37$ and hereby measured the transition between the paramagnetic and antiferromagnetic phase and obtained the Néel temperature, which decreases with increasing x -value. For this nanoparticle size the Néel temperatures correspond to the bulk values.

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